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(71) Applicant
Tecnoma SA (France),
54 Rue Marcel Paul, 51206 Epernay, France

(72) Inventor
Patrick Jean Marie Ballu

(74) Agent and/or Address for Service
A R Davies & Co,
27 Imperial Square, Cheltenham GL50 1RQ

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GB 1167820 GB 0900750 GB 0767881

(58) Field of search
F2V

(54) Pressure regulator, for example for an installation for spraying a treatment liquid

(57) The regulator incorporates a chamber 8 traversed by the liquid which is to be regulated under a pressure P. The outlet 10 is furnished with a valve 11a, 11b, having a closure member 11b carried by a piston 12 interposed in a fluid-tight manner (diaphragms 15 and 18) between the chamber 8 and an accumulator 14 filled with air under a pressure *p*. The assembly is dimensioned so that *p* is broadly independent of variations in P. The invention is applicable in particular to the regulation of the feed pressure of devices for spraying a liquid for treatment of plants or soil. An integral hand pump 22–25, a pressure gauge 33 and a volume adjuster 30–32 are provided.

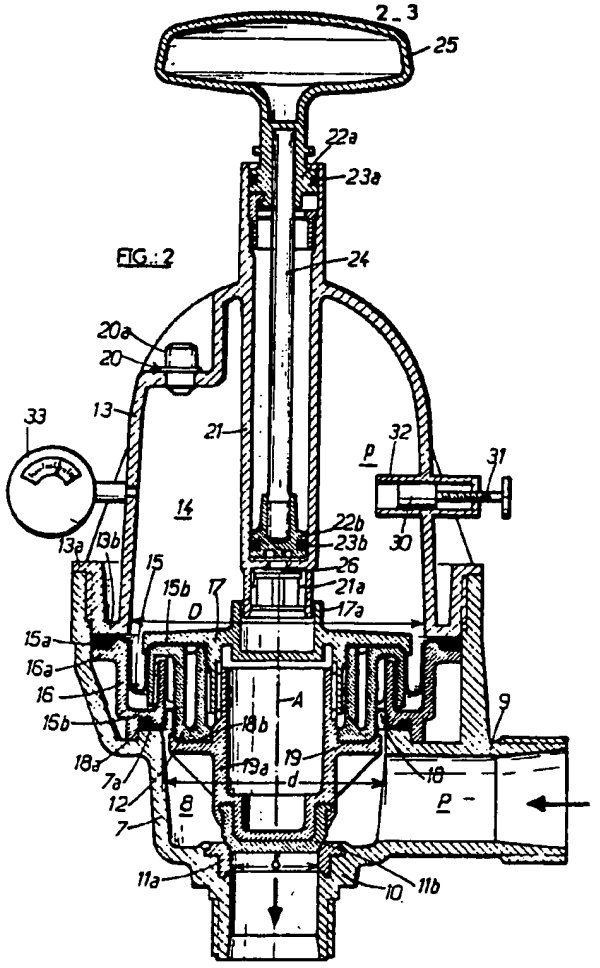

FIG.2

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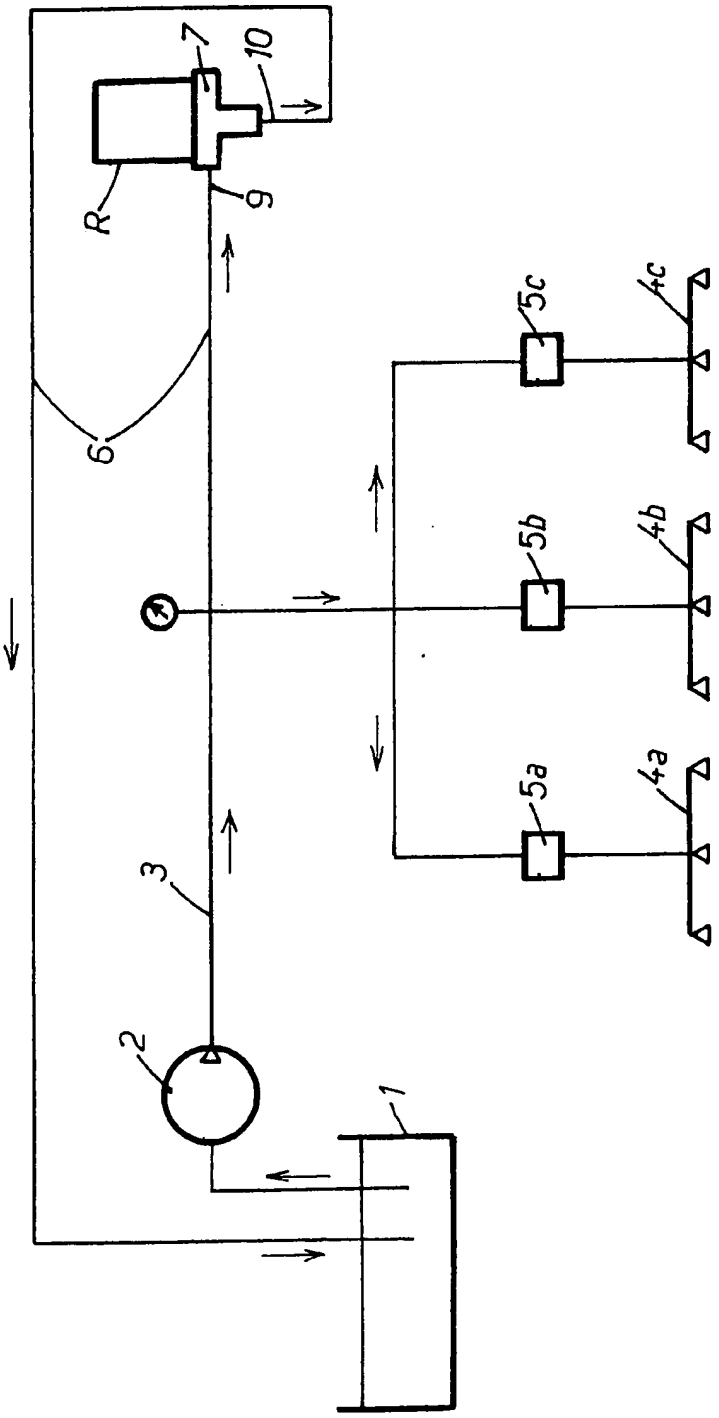


FIG.:1

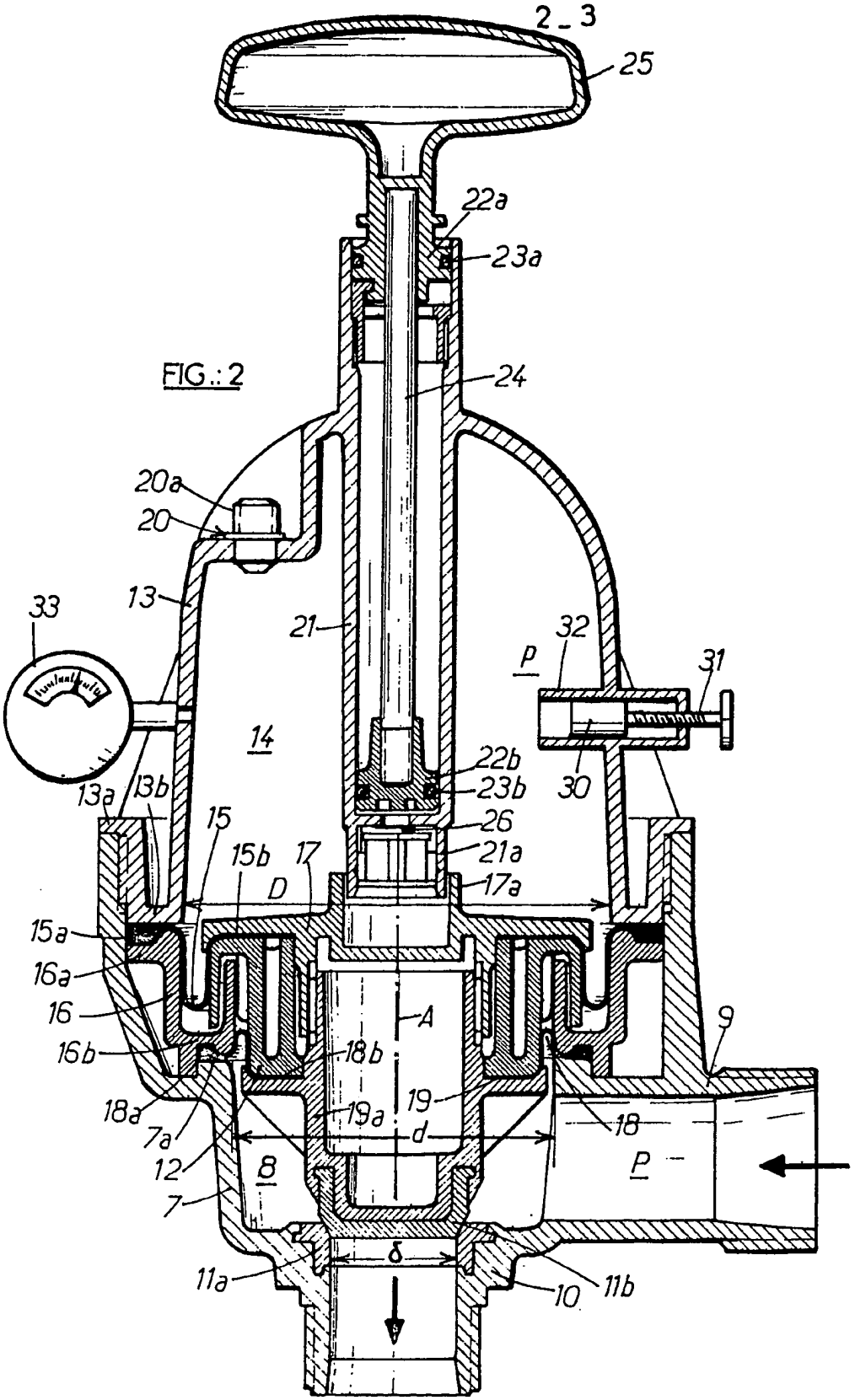
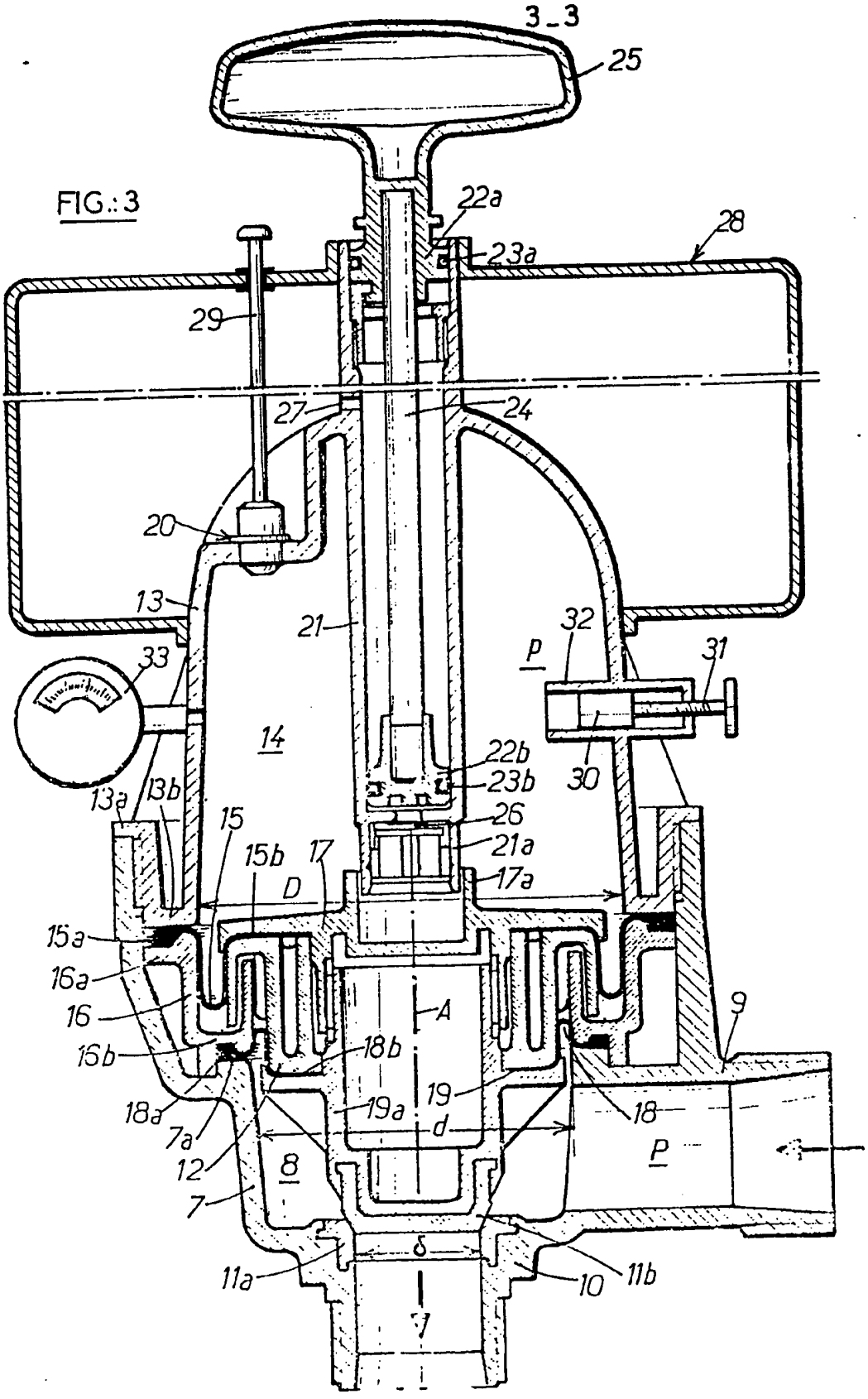

25
22a
23a
24
20a
20
13
33
21
32
31
P
14
22b
23b
30
13a
13b
15
26
15b
17
21a
D
17a
15a
16a
16
A
9
16b
18b
18a
19
7a
19a
d
18
12
8
P
7
δ
11a
10
11b

FIG.: 2

FIG.:3


3_3
25
22a
23a
28
29
27
24
20
13
21
32
31
P
33
14
22b
23b
30
13a
13b
15
15b
17
26
21a
17a
D
15a
16a
16
A
9
16b
18b
19
18
18a
19a
d
7a
12
8
P
7
δ
11a
10
11b
1

SPECIFICATION

Pressure regulator, for example for an installation for spraying a treatment liquid

The present invention relates to a pressure regulator, more particularly, but not exclusively, for an installation for spraying plants or soil with a treatment liquid.

Installations for spraying a treatment liquid, which are used in agriculture, arboriculture, etc., generally incorporate a fluid pump which supplies a number of spraying devices connected in parallel. For example several spraying racks may be arranged so that the supply of liquid to the racks can be initiated or shut off, the supply to some racks being controllable independently of the supply to other ones, for example according to the number of racks to be used for a particular spraying operation. The supply pressure in the different racks of the liquid to be sprayed, and consequently the flow of the liquid to sprayed, depends on the number of spraying racks in operation, so that the flow of each racks in operation depends on the number of racks which are not in operation. From another aspect, these spraying installations are generally equipped with pumps which are simple and robust but which have the disadvantage of delivering the treatment liquid in a pulsating manner, which entails further periodic variations of the supply pressure of the different racks and hence of the flow.

The pressure regulator according to the present invention is of the type indicated initially, and in such that, when incorporated in an installation for spraying treatment liquid, it avoids the disadvantages which have just been mentioned.

Pressure regulators are already known which incorporate a chamber having an inlet for a liquid under variable pressure, and a seat for an outlet valve member integral with a piston. Some of these pressure regulators have already been used in installations for spraying a treatment liquid, as described for example in the applicant's French Patent Application No. 77 28895 filed on the 26th September, 1977; in the installation described in this application, the piston of the regulator is interposed in a fluid-tight manner between the chamber and an auxiliary liquid circuit, for example an oil circuit, independent of the treatment liquid circuit, and is installed in an oscillating arm furnished with a measuring wheel meant to be carried along at a speed proportional to the speed of advance, in such a way as to ensure the spreading of a constant volume of treatment liquid in relation to unit of surface, despite any variation in the speed of advance of the vehicle which carries or tows the spraying installation. The pressure regulator described in this previous application is thus conceived in order to solve another problem, and it cannot be dissociated from a relatively complex device, adapted to submit the two faces of the piston of the regulator to the pressure of two distinct liquid circuits.

Likewise, pressure regulators of the type previously indicated are known in which a spring, or an analogous resilient element, applies to the piston a force, which can generally be adjusted, tending to push the outlet valve member towards its seat. These spring regulators present the following disadvantage. When the regulating pressure has to be increased, the spring has (for example) to be strongly compressed to a position in which the extent to which the spring can be further compressed is much less than when the spring is only in a relatively weakly compressed position, corresponding to a fairly weak regulating pressure; accordingly, the relative variations of the pressure to be adjusted for which such a regulator can compensate effectively are much less at high pressures than at low pressures.

According to the present invention, there is provided a pressure regulator, for example for an installation for spraying a treatment liquid, incorporating a chamber having an inlet for a liquid under variable pressure, an outlet valve having a seat and a closure member associated with the seat, a piston integral with the closure member and interposed in a fluid-tight manner between the chamber and an accumulator intended to be filled with a compressible fluid, the piston presenting a cross-section greater than that of the valve seat, and the chamber, the piston and the acumulator being dimensioned in such a way that the pressure of the fluid in the accumulator is in practice substantially independent of the pressure and of the flow of the liquid entering the regulator.

If, for example, a spraying installation, in which a pressure regulator according to the present invention is incorporated, is operating with all its racks in operation, and if, for example, the feeds of several of these racks in operation are simultaneously interrupted, the result is a significant increase in the pressure of the liquid entering the chamber of the regulator and, as result, an appreciable increase in the distance between the valve closure member and its seat, and hence an increase in the flow through the valve, and a reduction in the pressure of the liquid entering the valve. As the valve closure member is integral with the piston, the latter penetrates further into the accumulator but, due to appropriate dimensioning of the chamber, the piston and the accumulator, the amplitude of this displacement may be made so small that it results in an increase in the pressure in the accumulator which is negligible in practice; it will be understood that the strong increase which has been mentioned in the pressure of

the liquid entering is reflected in a practically negligible increase in the pressure of the liquid that exits from the regulator to feed the spraying racks kept in operation, so that the flow of these latter is not in practice modified by the cutting-off of the racks taken out of operation. In the same way, the periodic variations in pressure due to the pulsating delivery of the pump of the installation are broadly compensated for by the pressure regulator according to the present invention, and thus do not have repercussions in the liquid that exits from the regulator to feed the spraying racks.

Furthermore, as the compressibility of the fluid filling the accumulator is more or less independent of the pressure of this fluid, which has to be adapted to the pressure of the liquid entering the regulator according to the invention, the regulator can compensate with the same efficiency for the relative variations of pressure of the liquid entering, whether these are weak or strong, which is contrary to what happens in the case of known pressure regulators equipped with springs, as has been indicated previously.

Brief description of the drawings

Figure 1 is an outline diagram of an installation for spraying a treatment liquid, in which a pressure regulator according to the present invention is incorporated;

Figures 2 and *3* are axial sections of two pressure regulators according to the present invention, which can be utilised in the installation of Fig. 1.

Detailed description of the preferred embodiment

In Fig. 1, reference numeral 1 indicates a tank of treatment liquid, numeral 2 represents a pump suitable for aspirating the liquid in the tank 1 and delivering it in a pulsating manner into a main conduit 3 which supplies in parallel (for example) three spraying racks 4a to 4c which can be put into or out of operation by control devices 5a to 5c which can, for example, be operated manually. A pressure regulator R according to the present invention is inserted in a return conduit 6, which connects the main conduit 3 to the treatment liquid tank 1.

The embodiment of the regulator R, which is illustred in axial section in Fig. 2, comprises a casing 7 which is symmetrical about the axis A, for example, and made of a suitable cast material. The casing 7, whose upper surface is open, delimits a chamber 8 into which there opens a lateral inlet pipe 9 which, in the installation illustrated in Fig. 1, is connected to the general conduit 3. The lower wall of the casing 7 is traversed by an outlet pipe 10 which extends downwards in the direction of the axis A. At the outlet of the pipe 10 from chamber 8 there is a valve seat 11a, made of a suitable resistant material, with which a valve member 11b can cooperate, the valve member 11b likewise being made of a suitable resistant material. The seat 11a and the member 11b can interact by means of ground surfaces, for example frustoconical around an axis A. A piston 12 is interposed between the chamber 8, delimited by the casing 7, and the open lower face of a bell-shaped component 13 whose open lower face is provided with a lateral flange 13a serving to connect it in a fluid-tight manner—by known means, not illustrated—to the upper edge of the casing 7, in such a way that the said component 13 delimits, above the piston 12, a chamber 14 of large volume constituting (as will be explained in greater detail below) an air accumulator. Sealing at the level of the piston 12 is ensured, on the side of the air accumulator 14, by a flexible upper diaphragm 15 whose outer edge 15a is embedded between a lower flange 13b of the bell-shaped component 13 and an external radial flange 16a of a collar 16 coaxial with the axis A, while the inner edge 15b of the diaphragm 15 is embedded between the upper face of the piston 12 and an annular element 17 which is fixed to the upper face of the piston 12 by suitable means which are not illustrated. In the same way, the sealing of the piston 12 on the side of the chamber 8 is ensured by a flexible lower diaphragm 18 whose outer edge 18a is embedded between a shoulder 7a on the inner face of the casing 7 coaxial with the axis A and a radial inner flange 16b of the collar 16, while the inner edge 18b of the diaphragm 18 is embedded between the lower face of the piston 12 and an annular element 19 which is fixed to the lower face of the piston 12 by suitable means which are not illustrated. The arrangement is such that the cross-section of the assembly formed by the piston 12 and the diaphragms 15 and 18 has different values, and more particularly such that the cross-section on the side of the air accumulator 14 has a diameter D significantly greater than the corresponding diameter *d* of the cross-section on the side of the chamber 8. Furthermore, the lower annular element 19 forms an outer radial flange on a cylindrical sleeve 19a coaxial with the axis A. In this embodiment the two elements 19 and 19a are integral, being for example casted together, and the sleeve 19a extends below the annular element 19 in such a way as to support the valve member 11b, this latter having for example the shape of a cupel, whose sidewall has been sunk during casting in the lower part of the sleeve 19a.

In the embodiment of Fig. 2, the upper wall of the bell-shaped component 13, which constitutes the air accumulator, is traversed by an automatic closure valve 20 which can be connected, for example by means of an external thread 20a, to the mouth of a tube

connecting with a source of compressed air, such as an air compressor or a compressed air cylinder, for filling the chamber 14 of the air accumulator. This automatic closure valve is of a well-known type, which it is unnecessary to describe in detail, and which is able to be opened temporarily by a simple manual action, for the total or partial emptying of the chamber 14 of the accumulator. Moreover, an air pump, more particularly a manual pump, is mounted coaxially with the axis A, in such a way as to traverse the upper wall of the bell-shaped component 13. The cylindrical housing 21 of this manual pump is for example cast with the bell-shaped component 13. It extends to a suitable height above the component 13 and, inside the latter, as far as the level of the upper annular element 17. In this embodiment, the housing 21 of the manual pump is prolonged downwards by a socket 21a which engages with clearance inside a tube 17a, cast on the upper face of the upper annular element 17, in such a way as to ensure guidance of the movement of the assembly 12, 15, 17, 18, 19, 19a, 11b in the direction of the axis A. In the housing 21 of the pump, two pistons 22a and 22b, provided with sealing gaskets 23a and 23b, are slidable and are joined by a metal rod 24 whose upper end is prolonged by a manipulating handle 25. At the lower end of the pump housing 21 there is provided a delivery valve 26 of a known type wich allows delivery into the chamber 14 of the air accumulator of atmospheric air which has been compressed in the pump housing 21 when the operator has pushed downward the handle 25.

The operation of the spraying installation illustrated in Figs. 1 and 2 and described above is as follows. If p represents the air pressure in the chamber 14 of the accumulator, P the pressure at a given moment of the treatment liquid in the inlet pipe 9, S the surface area of the movable assembly 12, 15, 17 on which the pressure p is exerted, s the surface area of the movable assembly 12, 18, 19 which is exposed, in the chamber 8, to the pressure P, σ the effective section of the valve member 11b, and δ the diameter of the valve seat 11a, one has:

(1) $S = \pi D^2/4$
(2) $s = \pi d^2/4$
(3) $\sigma = \pi \delta^2/4$

When the valve 11a, 11b is closed, the pressure P of the liquid entering, which acts in the chamber 8, exerts on the piston and diaphragm assembly 12, 15, 18 an ascending force F_a given by:

(4) $F_a = P \,.\, (s-\sigma)$,

while the air contained under pressure in the chamber 14 exerts on the same assembly the descending force F_d given by:

(5) $F_d = p.S$

When the assembly 12,15,18 is in equilibrium under the action of these two opposing forces F_a and F_d, one has the relationship:

(6) $P \,.\, (s-\sigma) = p.S.$,

from which it can be deduced that the relation of the pressure p of the air in the accumulator to the pressure P of the liquid entering is:

(7) $p/P = (s-\sigma)/s$,

which can be made small in so far as the difference in the surfaces $(s-\sigma)$ can be dimensioned in such a way as to be very much less than S; this facilitates the filling of the accumulator 14 by means of the air pump when P is increased.

The embodiment of the invention which is illustrated in Fig. 2 comprises in addition the following two improvements. Firstly, the interior volume of the accumulator 14, and thus also the pressure of the air that fills it when the valve 20 is closed, can be precisely adjusted by a plunger-piston 30 which can be moved from the outside by means of a manual control 31 in a cylinder 32 which opens into the interior of the accumulator 14 and which is, for example, cast together with the wall of the accumulator 14. Secondly, the air pressure in the accumulator 14 can be read on a manometer 33 mounted directly on its wall.

The present invention is not limited to the embodiment described above. It embraces all its variants. As has already been indicated, the filling of the chamber 14 of the air accumulator, instead of being effected with the aid of the hand pump 21 to 26, could be effected with the aid of a compressor or of another source of compressed air, connected to the valve 20. The means for sealing the piston 12 are optional; the flexible diaphragms 15 and 18 could be replaced by other sealing elements such as annular joints. It is not indispensable for the piston 12 to be fitted as a multiplier of the pressure p in the air accumulator chamber 14. Of course, the pressure regulator according to the present invention can be utilised in other hydraulic circuits, and is not limited only to installations for spraying or injecting a treatment liquid.

In the second embodiment of the invention, which is illustrated in Fig. 3, the accumulator 14 can be filled with a compressible fluid other than air, more particularly a gas or a vapor which must not escape into the atmosphere for one reason or another (noxiousness, high cost etc). In this case, the upper part of the accumulator 14 is capped by a fluid-tight tank 28, in which the compressible fluid is

stored under a pressure preferably significantly less than the lowest value to which its pressure in the accumulator 14 can be adjusted. In this tank 28 open the aspiration outlet 27 of the hand pump 21–26 and the valve 20, which, in this case, has to be provided with a member 29 passing through the tank 28 in a fluid-tight manner and allowing the opening of the valve 20 to be controlled from the outside. Of course, the tank 28 and/or the pump 21–26 could also be independent of the accumulator 14 to which they would be connected by suitable pipes.

CLAIMS

1. A pressure regulator, for example for an installation for spraying a treatment liquid, comprising a chamber having an inlet for a liquid under variable pressure, an outlet valve having a seat and a closure member cooperating with the seat, a piston integral with the closure member and interposed in a fluid-tight manner between the chamber and an accumulator intended to be filled with a compressible fluid, the piston presenting a cross-section greater than that of the valve seat, and the chamber; the piston and the accumulator being dimensioned in such a way that the pressure of the fluid in the accumulator is in practice substantially independent of the pressure and of the flow of the liquid entering the regulator.

2. A regulator according to claim 1, wherein the accumulator is provided with an accumulator valve, preferably with automatic closure, for filling and/or for emptying of the accumulator.

3. A regulator according to claim 1 or 2, wherein a pump, for example a hand pump, is mounted on the accumulator in such a way as to allow it to be filled with compressible fluid up to the desired pressure.

4. A regulator according to claim 3, wherein the accumulator is adapted to be filled with air taken from the ambient atmosphere, where the accumulator valve and the pump have their outlets.

5. A regulator according to claim 3, wherein the accumulator valve and the inlet of the pump communicate with a tank, where the compressible fluid is stored under a pressure significantly down than its pressure in the accumulator, this tank being preferably integral with the accumulator and with the housing of the pump, means being provided to control the accumulator valve manually.

6. A regulator according to claim 1, wherein means are provided for adjusting from the outside the interior volume of the accumulator, for example in the form of a plunger-piston which can be moved, for example by means of a manual control, in a cylinder opening into the interior of the accumulator and, for example, integral with the wall of the accumulator.

7. A regulator according to claim 1, wherein the piston is adapted to act as a multiplier of the pressure in the accumulator.

8. A regulator according to claim 7, wherein the two faces of the piston have different cross-sections and are joined in a fluid-tight manner, for example by flexible diaphragms, the larger face to the sidewall of the accumulator, and the smaller face to the sidewall of the chamber.

9. An installation for spraying or injecting a liquid, for example a liquid for treatment of plants or soil, equipped with a pressure regulator according to claim 1, and having the inlet of the chamber of the regulator connected to the output of a liquid pump, to which a plurality of spraying devices are connected in parallel, the outlet valve of the regulator being connected to a return conduit terminating at a liquid tank.

10. A fluid-tight receptacle for a fluid under pressure, more particularly an accumulator for a pressure regulator according to claim 1, wherein the body of a pump for filling the receptacle is integral with the wall of the receptacle, being for example cast together with the wall.

11. A pressure regulator substantially as hereinbefore described with reference to the accompanying drawings.

12. An installation for spraying or injecting a liquid, substantially as hereinbefore described with reference to the accompanying drawings.

13. A fluid-tight receptacle for a fluid under pressure, substantially as hereinbefore described with reference to the accompanying drawings.

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